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Ensuring Institutional Success

POLICIES AND PROGRAMS CRITICAL FOR GREATER ENERGY EFFICIENCY

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Abstract

In 2018 businesses, households and government enterprises throughout the global economy spent an estimated €7.4 trillion to meet the many demands for various energy services. Current projections suggest that the present scale of annual expenditures may increase by more than 60 percent to €12.0 trillion by 2050 (with all costs expressed in real 2018 values). Although the global economy derives important benefits from the purchase of many energy services, the inefficient use of energy also creates an array of costs and constraints that burden our social and economic well-being. Among these costs or constraints are increased health costs, air pollution, climate change and a less productive economy—especially over the long term. Yet there is good news within the countless energy markets throughout the global economy. Whether improved lighting in homes and schools, transporting people and goods more efficiently, or powering the many industrial processes within any given nation, there are huge opportunities to improve the productive use of energy in ways that reduce total economic costs. And those same energy efficiency upgrades can also reduce greenhouse gas emissions that drive climate change, as well as lessen other impacts on both people and the global environment. However, as this manuscript suggests, it will take an adequately funded set of smart policies and effective programs, including a skilled work force, to drive the optimal scale of energy efficiency investments.

Keywords: energy efficiency, economy, energy policy, program costs.

JEL: Q49, D12, Q48, D24.

Introduction

In 2018, the 7.5 billion people within the global economy spent more than €7.4 trillion to meet their combined needs for energy services. Current projections suggest that the present scale of expenditures may nearly grow in real terms to €12.0 trillion by 2050[1]. The many payments made each day or each month, both now and into the future, will enable a growing population to cool and light their homes, drive to work, listen to music, or simply watch television. For some, the payments may simply provide the fuel necessary to cook their food. For others, the disbursements will power their many business enterprises. Purchases of electricity will enable access to the Internet, as well as filter and purify the water that is delivered to local homes, schools, and businesses each and every day.

Although the global economy derives important benefits from the use of many energy resources, the inefficient use of energy also creates an array of costs and constraints that burden our social and economic well-being. For example, the incomplete combustion of fossil fuel resources releases massive amounts of pollutants into the air. The current mix of energy resources used to support worldwide economic activity will also result in 4–7 million people who will die prematurely, and hundreds of millions more who will become ill from exposure to air pollution [Jacobson et al., 2017]. The International Monetary Fund (IMF) suggests that pollution damage from burning fossil fuels are immense, on the order of $3–4 trillion per year [Coady et al., 2015]. The International Energy Agency confirms this scale of the health and air pollution problem[2]. In addition, the inefficient use of energy in 2018, according to the International Energy Agency, also dumped another 33.1 gigatonnes of carbon dioxide into the atmosphere. This contributes to an acceleration of global climate change.

Currently, the global economy may be at a crossroads. As detailed in a variety of recent studies, it turns out that worldwide, the economy may only be 16 percent energy-efficient [Laitner, 2015; 2019, based on Ayres, Warr, 2009; Voudouris et al., 2015; see also, Blok et al., 2015]. Said differently, of all the high-quality energy resources consumed within the international community, an estimated 84 percent is wasted. As already indicated, we see a lot of that waste in the form of increased air pollution and carbon dioxide emissions. Other wastes may include fly ash from power plants and the disposal of industrial chemicals. The in-

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[1] Laitner J. A. *Working Memorandum on Cost of Global Energy Services*. Tucson, AZ, Economic and Human Dimensions Research Associates, 2019. https://theresourceimperative.com/wp-content/uploads/2019/10/Laitner-Working-Estimate-of-Global-Energy-Expenditures-2019.pdf.

[2] Energy and Air Pollution: World Energy Outlook Special 2016. Paris, OECD/IEA, 2016. https://www.iea.org/publications/freepublications/publication/weo-2016-special-report-energy-and-air-pollution.html.

efficient use of energy also creates serious economic and competitive challenges for the economy should it continue at the aforementioned 84 percent waste level along with the current and inefficient patterns of energy production and consumption.

So, whether concerns about fuel or energy poverty, energy security, or global climate change, there is an increasing emphasis on, and review of, the role that energy plays within any given national or regional economy. And while there are large opportunities to promote the more efficient use of energy and other resources, the mere existence of an opportunity does not guarantee a positive outcome. In short, the more productive use of energy and resources will not automatically happen. *It will take purposeful effort, guided by smart policies and programs, to drive the necessary activities and investments to achieve optimal, large-scale benefits*[3].

But how do we do things differently in ways that accelerate the more productive use of energy resources—at sufficient scale—over the next three decades or so? In the sections that follow, we briefly explore what we call the "economic imperative of energy efficiency". We then examine the magnitude of the effort and the investments that will be essential to elevate the performance of the global economy. We especially focus on, and review the likely scale of, the policies and programs that will be required to support that level of transition. Finally, we offer a brief survey of financial tools that can stimulate a sufficient level of investments even as they also provide funding for needed policies and programs.

1. The Economic Imperative of Greater Energy Efficiency

The world economy sits at the crossroads of both challenges and opportunities. On the one hand, the global economy shows signs of a lagging performance—weakened by the inefficient use of resources. Over the period 1990–2008, for example, the volume of gross domestic product (GDP) per inhabitant within the world community—a useful proxy of economy-wide productivity—grew at a reasonable rate of 2.0 percent per year. Over the next 9-year period through 2017, however, per capita GDP weakened somewhat, dropping to 1.4 percent[4]. It is a mixed

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[3] As the term is used here, "at scale" generally means a reduction of energy use by 40 percent or more over a projected level of consumption by the year 2050. Examples of scenarios which achieve that scale of reduction can be found in European Climate Foundation (2010) [Laitner et al., 2012; Teske et al., 2017] and Metropolitan Region of Rotterdam-The Hague (2017). It might be worth noting that, as an update to an earlier study, [Laitner et al., 2012; Nadel, 2016] found that 13 efficiency-specific measures in the United States, if pursued aggressively, would reduce 2050 energy use by 50 percent relative to then currently predicted levels. But as he also noted, achieving those energy efficiency savings would require an expansion of energy efficiency efforts well beyond business-as-usual.

[4] Energy Information Administration (EIA) 2017. International Energy Outlook 2017. Washington, DC, U.S. Department of Energy. https://www.eia.gov/outlooks/ieo/; Energy Information Administration (EIA) 2017. Integrate Dataset from the International Energy Statistics and International Energy Outlook 2050. Washington, DC, U.S. Department of Energy. https://www.eia.gov/beta/international/.

story, however, depending on whether we are looking at the 35 member nations of the Organisation for Economic Co-operation and Development (OECD), or whether we examine other emerging economies, the so-called non-OECD countries.

While real per capita GDP of the developing nations (non-OECD countries) since 1980 continues to improve, the rate of improvement in the last few years may be diminishing. More critically, it appears that the rate of improvement will continue to deteriorate by 1 percentage point or more. While that may not sound like a big deal, if a nation drops from a GDP growth of 3 percent down to 2 percent, that means its real income over the next 30 years could be nearly 25 percent smaller by 2050. Following a more precipitous pattern, the OECD nations have gone down from a robust 2.0 percent average growth rate, now trending downward toward 1.0 percent or less[5]. Indeed, a long-term OECD forecast from 2017 to the year 2050 points to a similarly weakening growth rate[6]. There are many reasons for a possible slumping of economic well-being, but it is clear that our current inefficient use of energy and other resources, and the enormous drag on economic production it causes cannot be sustained [Ekins, Hughes, 2017; Kümmel, 2011; 2013; Laitner, 2019, building on Ayres, Warr, 2009; Voudouris et al., 2015].

With their very hectic and busy work and travel schedules, most households, businesses and political leaders understandably do not have the time to step back and think through how the economy might be operating across the larger dimensions of climate and energy policies. Yet, there is an increasing number of studies suggesting that energy and resource efficiency can build a more robust and sustainable economy. The question is how to make that information more accessible, on the one hand, but to also put that information to work in ways that provide an immediate set of goods and services that maintain social and economic well-being. Notwithstanding concern for potentially lagging productivity, for example, a later OECD report noted that low greenhouse gas emission pathways, including investments in renewables and energy efficiency upgrades, could stimulate long-run economic output by up to 2.8 percent, on average, across the G20 countries in 2050[7]. Moreover, the United Nations Environment Programme (UNEP) has suggested that the smarter use of energy and other resources can add $2 trillion to the global economy [Ekins, Hughes, 2017].

As Fig. 1 below attests, drawing on data from the International Energy Agency, it appears that energy efficiency has already been the main-

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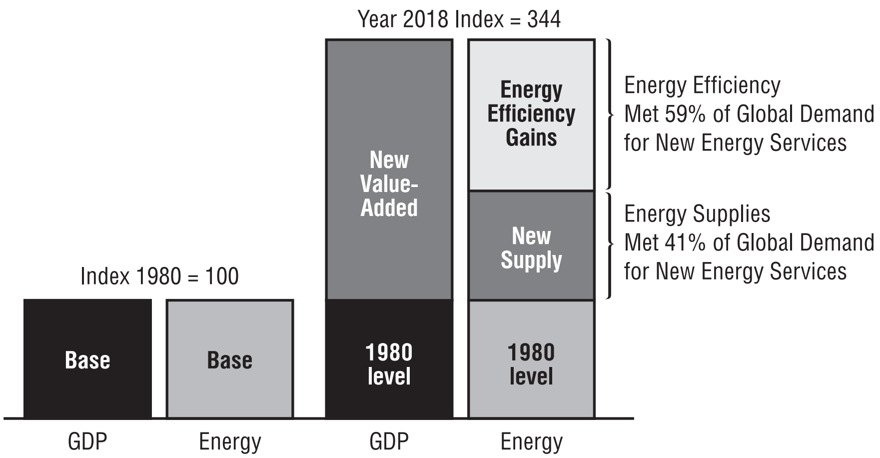
[5] World Energy Statistics. International Energy Agency (IEA). Paris, 2017. http://www.iea.org/bookshop/752-World_Energy_Statistics_2017.

[6] The Future of Productivity. Paris, OECD Publishing, 2015.

[7] Investing in Climate, Investing in Growth. OECD, 2017.



Source: based on data from the International Energy Agency, August 2019.

Fig. 1. **Global Demand for New Energy Services**

stay in supporting new demands for energy services since 1980. While new energy supplies provided 41 percent of the new demands, greater levels of energy efficiency supported 59 percent. The scale of energy efficiency gains is even more significant for both the United States (85 percent) and OECD nations (77 percent) as indicated in Table 1. Although a lesser range, even the non-OECD countries benefited from energy efficiency resources that provided 53 percent of new services demands.

Table 1

Key Energy Service Demand Metrics (1980 and 2018)

Region	GDP per Unit of Energy (2010 USDPPP)		Total Primary Energy Use (Mtoe)		New Energy Service Demands Since 1980	
	1980	2018	1980	2018	Supply	Efficiency
World	34,174	117,537	7,208	14,391	41%	59%
United States	6,529	17,796	1,805	2,258	15%	85%
OECD Nations	20,797	51,432	4,068	5,419	23%	77%
Non-OECD Nations	13,376	66,105	3,140	8,972	47%	53%

Source: International Energy Agency data, September 2019.

With that unexpected contribution to the expansion of the global economy, many might assume that we likely used up the cost-effective energy efficiency opportunities. A closer examination reveals, however, that huge opportunities remain to accelerate even greater gains in energy efficiency. Appropriately designed and supported policies and programs are key to future successes. The section that follows explores a number of recent assessments to highlight that opportunity.

2. The Opportunity and Scale of Needed Investments

In February of 2017, the Metropolitan Region of Rotterdam–The Hague (MRDH) released a major assessment and strategic plan that it calls *Roadmap Next Economy*[8]. The region is now home to 2.3 million people. Despite an expected 49 percent growth in per capita GDP by 2050, community and business leaders laid out a policy framework and investment plan that would reduce total energy use by more than 40 percent compared with current levels of consumption. Together with the deployment of renewable energy resources, the roadmap was intended to also reduce energy-related carbon dioxide emissions to near zero, also by 2050. Beyond the clean energy transition within MRDH, it was further determined that the more productive use of energy and other resources would expand the regional economy by about 5 percent over the reference case. Two things are especially notable in that roadmap.

First, an initial modeling exercise indicated a cumulative investment of €63 billion was necessary to drive that level of performance improvement. That magnitude of outlay, over the 34-year period 2017 through 2050, would be the rough equivalent of 64 percent of one year's current GDP within the MRDH region. The money would be spent to upgrade buildings and structures, technologies and equipment, and public infrastructure. The latter also included a buildout of the digital substructure to enable a more optimal use of resources. But second, the region also recognized that technology investment alone was insufficient to warrant an optimal outcome. An active policy and program staff, together with contractor support, travel and other overhead expenses, were also vital to ensure the most advantageous result. In the aggregate, *the various policy and program initiatives within MRDH* might require the spending of €100 million per year in addition to the technology and infrastructure investments. In other words, the policy and program spending is a necessary complement to technology investments—if the roadmap is to effectively elevate the larger performance of the MRDH economy.

Despite those combined costs, including debt service payments to cover investor or borrowing costs, the region concurred with the overall financial aspects. The reason? The roadmap was still expected to save a net of €700 million per year—even as it pushed energy-related carbon emissions down to near zero by 2050. The modeling exercise additionally indicated that, as the roadmap pushed the innovation frontier further out, the MRDH region would become a more robust and resilient

[8] Roadmap Next Economy. Metropolitan Region of Rotterdam–The Hague (MRDH), 2017. https://mrdh.nl/RNE.

economy, one that further supported a net average gain of about 60,000 jobs within the Netherlands.

3. Working Estimates of Future Energy Efficiency Investment Magnitudes

At this point we want to generate two separate estimates which might inform OECD and non-OECD economies about the scale of efforts to support a transition to a 40 percent improvement in energy efficiency, together with greater economic productivity and performance. The first one, drawn from an array of studies summarized in Table 2 that follows on the next page, is a working assessment of the investment necessary to drive a large efficiency improvement at the global level by 2050. The second one is a working approximation of the essential policy and program costs that are likely needed to ensure the most advantageous outcomes from the anticipated technology investments.

We approach the two estimates more as thought experiments or Fermi problems than a precise estimate of costs [Von Baeyer, 1993]. The reason for this approach is the lack of consistent data to allow a full and precise set of cost estimates. A Fermi calculation, involving the multiplication of several estimated factors, is likely to be more reasonably accurate than first supposed. This is because there are probable factors that are estimated too high, while other factors are estimated too low. Assuming there is no consistent bias in the estimated factors, such errors will partially, if not more completely, cancel each other out. Thus, we are essentially modeling "for insights, not numbers" [Huntington et al., 1982].

As a starting point, we have reviewed more than 150 publications for their immediate insights in this regard. As Table 2 highlights, we compare investment magnitudes from 12 different studies as the primary basis of the working estimate generated for the International Partnership for Energy Efficiency Cooperation (IPEEC) as it is reviewed in this manuscript. The conclusion of the IPEEC exercise is summarized as the 13th and last study cited in the table [Laitner et al., 2018].

An opening review indicates a scale of clean energy or energy efficiency investment that ranges from a global $27 trillion over 30 years, about 24 percent of one year's GDP (also globally) to eliminate almost all equivalent carbon emissions [Drawdown.., 2017], to a European Union estimate for buildings-only analysis with energy savings of 34 to 71 percent at a cost of €343 billion to €584 billion. These last figures are about 3 to 5 percent of one year's GDP in the EU[9]. The International Energy Agency references a global efficiency scenario that lowers total

[9] Europe's Buildings Under the Microscope. Buildings Performance Institute Europe (BPIE), 2011. http://bpie.eu/documents/BPIE/LR_%20CbC_study.pdf.

energy use by about 24 percent from 2040 projections for an investment that is about 9 percent of GDP in 2015[10]. We can imagine a larger scale of necessary investment depending on whether we also include an upgrade to the larger infrastructure, the deployment of renewable energy technologies and systems, and improved communication technologies to make more efficient use of resources.

To provide a reasonable average annual scale of investments, program expenditures, and energy bill savings (highlighted in Fig. 2) we made a number of critical but reasonable assumptions[11]. We began with the estimated €6.4 trillion of world energy expenditues in 2017. Drawing from the array of studies previously cited, we set a 2050 goal of a 40 percent savings of a forecasted growth in energy demand. Moreover, we followed the magnitudes of technology investments in the Table 2 assessments (whether energy or carbon emission reductions), but also tapped into other available studies. Again, drawing from a variety of published energy efficiency scenarios, we assumed an average payback of 7 years (which might range from less than 1 to more than 13 years, but which averaged 7 years).

Table 2

Estimates of Investments in Large-Scale, Productive Energy Transitions

Study (Year)	Regional Impact	Cumulative Investment
[Drawdown.., 2017]	***Global***: Beginning in 2020, 1,051 $GtCO_2e$ removed by 2050, with the possibility of much greater EE with 100% renewables also by 2050	***Global***: $27 trillion over 30 years. With a net operating savings of $74 trillion (2014$). Total investment is about 24% of one year's GDP in 2014
[Jacobson et al., 2017]	***Global***: 100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 countries by 2050	***Global***: ~$124.7 trillion (2013 USD). About 118% of one year's GDP in 2013
The 2017–2050 négaWatt Scenario. France, Valence: Negawatt Association, 2017	***France***: Substantial sustainability and efficiency outcomes over period 2017 to 2050. With 100% renewables also by 2050	***France***: Cumulative investment of €39 billion (in 2017 values), about 2% of one year's GDP, with an overall savings of €78 billion over the period 2017–2050
Roadmap Next Economy, 2017	***Metropolitan Region Rotterdam–The Hague***: Greatly improved energy efficiency, with buildout of digital infrastructure and a 100% renewable energy by 2050	***Metropolitan Region Rotterdam–The Hague***: €63 billion (in 2013 values). About 64% of one year's GDP to upgrade the combination of existing energy technologies and local infrastructure between 2017 and 2050

[10] World Energy Outlook 2017. Paris, France: OECD/IEA, 2017

[11] Laitner J. A. *Working Memorandum on Cost of Global Energy Services.*

End of table 2

Study (Year)	Regional Impact	Cumulative Investment
[Zuckerman et al., 2016]	***Global*: Scaling up clean energy financing to at least US $1 trillion a year could reduce annual GHG emissions ~20% from 2015 levels by 2030	***Global***: At US $1 trillion (in 2015 values). About 1% of GDP for clean energy improvements and greater levels of energy efficiency
World Energy Outlook 2017	***Global***: Energy use 27% below 2040 forecasted levels while CO_2 emissions are 57% below 2040 levels (43% below 2015 levels)	***Global***: $11.3 trillion (2016 USD), which is about 10% of GDP in 2015
[Teske et al., 2015]	***Global***: 80% GHG reduction by 2050 compared with 1990 levels	***Global***: In the decarbonized pathways, the capital goes up from about $28.7 trillion to about $81.5 trillion (in 2014 USD) a year over the period 2012 to 2050. The net increase of $52.9 is 48% of one year's GDP
[Keyser et al., 2015]	***USA***: An investment strategy to increase the nation's energy productivity and reduces energy use 25% from current levels by 2030	***USA***: With an investment of ~$100 billion per year (2010 values). That is about 0.6% of GDP annually to ensure greater productivity
[Stern, 2015]	***Global***: Looking at a 15-year window (by 2030) to shift investment momentum that reduces greenhouse gas emissions by ~60% from today	***Global***: Increasing infrastructure investments about $2.5 trillion above current levels over the period 2015 through 2030
Europe's Buildings Under the Microscope, 2011	***European Union***: Building stock assessment only with different scenarios of efficiency improvements, ranging from 34 to 71% savings in 2050 compared with current consumption	***European Union***: With two of the five non-baseline scenarios reported here, total investments are estimated to be €343 to €584 billion through 2050. As this includes buildings-only assessments, the size compared to GDP is on the order of 3% to 5%
Roadmap 2050: a Practical Guide to a Prosperous, Low-Carbon Europe. European Climate Foundation (ECF), 2010	***European Union***: 80% GHG reduction by 2050 compared with 1990 levels	***European Union***: In the decarbonized pathways, the capital goes up from about €30 billion to about €65 billion a year over the period 2010 to 2050. When delayed by 10 years, the required annual capital spent in 2035 goes up to over €90 billion per year. That net increase will be 11% to 19% of one year's GDP
[Laitner et al., 2012]	***USA***: Exploring a 42% to 59% reduction from projected 2050 values, or a 30% to 50% reduction from total primary energy use from 2010 levels	***USA***: $2.4 to $5.3 trillion (in 2009 values) over the period 2012 to 2050. About 17% to 37% of one year's GDP
IPEEC 2019 (this review)	***Global***: A 40% reduction of projected total primary energy use by 2050, which is about 19% below 2017 levels	***Global***: Including both program costs of €3.3 trillion, and investment costs of €24.9 trillion, the combined €28.1 trillion (in 2017 values) over the period 2018–2050. About 29% of one year's GDP

These assumptions all together suggest an aggregate cumulative cost on the order of €28 trillion shown in Table 2 [Laitner et al., 2018], or about 29 percent of one year's GDP. However, the aggregate costs also include expenditures for policies and programs which more likely *enable the right scale and the right mix of investments*, which, in turn, are more likely to achieve a 40 percent energy efficiency gain by 2050. We next describe the assumptions that underpin our estimates of these latter costs.

4. Estimates of Policy and Program Costs to Drive Energy Efficiency-Led Investments

Again consistent with the many studies we reviewed, the working hypothesis holds that the mix of policy and program costs might be 20 percent of investments in the early years, but decline to about 8 percent by 2050. The slow reduction in program costs over time presumes a form of "learning" as well as "economies of scale" and "economies of scope". That is, both experience and expansion of the market decrease this form of fixed costs over time. It also reflects working estimates that include public and private costs. A final assumption is that policy and program costs, as well as technology and infrastructure investments, would be covered by market investors, or by borrowing necessary funds at 5 percent interest over a 20-year period[12].

A more detailed background on such costs and how they might be financed follow in the next two sections of this report. Here we integrate the immediate findings into Figs. 2 and 3 as part of a "Global Energy Efficiency Innovation Scenario". The intent is to provide policymakers and business leaders with a meaningful context on the scale and capacity of such programs to deliver energy efficiency improvements, together with net energy bill savings. At this point, all expenditures and savings (in real or constant 2018 values) were averaged at the global scale over the individual years 2020 through 2050. Fig. 2 below shows the resulting values as annual averages over the full time horizon. Fig. 3, on the other hand, displays them as a year-by-year assessment of costs and energy bill savings.

Fig. 2 begins with a business-as-usual (BAU) average annual energy cost of €9,400 billion, again over the period 2020 through 2050. Since a major focus of this report is on the critical role of policies, programs and practices to drive down the overall cost of energy services (discussed more fully in the section that follows), we immediately note an implied increased annual spending of €200 billion to ensure a likely

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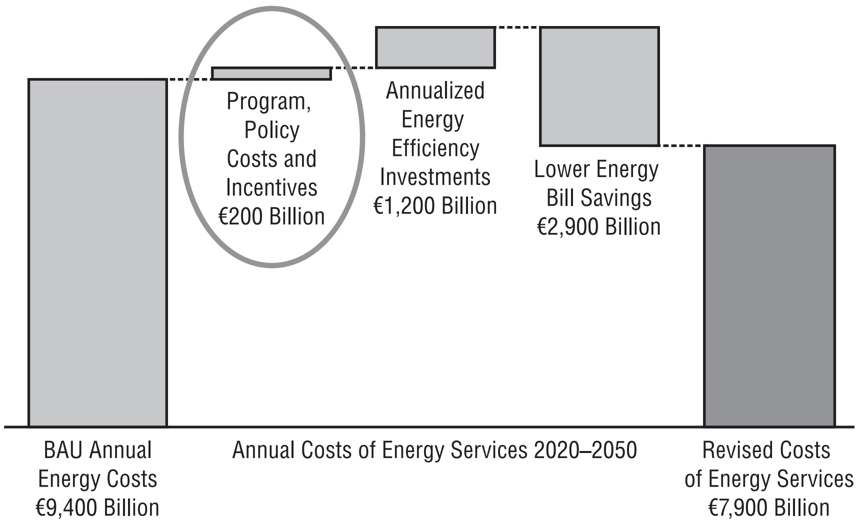
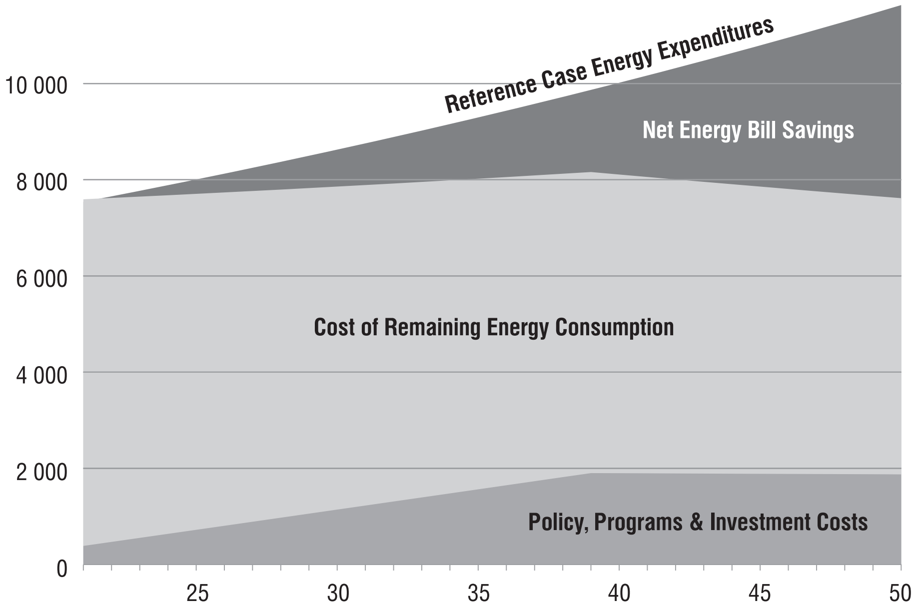
[12] More of the analytical details can be found in [Laitner et al., 2018].



Source: adapted from [Laitner et al., 2018].

Fig. 2. **Average Annual Costs from a Global Energy Efficiency Innovation Scenario (**2018 €)



Source: adapted from [Laitner, 2019].

Fig. 3. **Impact of a Global Energy Efficiency Innovation Scenario** (billions of 2018 €)

positive outcome[13]. As a result, we then have the mix of the €200 billion of program expenditures, coupled with the amortized €1,200 billion of efficiency investments, which, in turn, generates the lower energy bill savings (~€2,900 billion). This results in a lower average cost of energy services (~€7,900 billion). The net gain is an average €1,500 billion per year. And, as suggested previously, greater energy productivity would likely increase the robustness of the global economy—for both the OECD and non-OECD nations. That, in turn, would amplify the benefits of these policy and program investments. Fig. 3 highlights these global energy expenditures as they might appear annually over the same period 2020 through 2050. The key insight? Without the foundation of smart policy and program investments, the net energy bill savings is likely to be much less than shown here.

5. Building Momentum with Smart Policies and Programs

If we are to solve the challenges posed by energy and resource inefficiencies, preemptive actions will require what we call "purposeful effort" and "directed actions" that, in turn, will require large sums of productivity-led investments. Yet, as already put forward, large expenditures on infrastructure and technology by themselves will be insufficient to achieve any new outcome. Current investments and program deployment are moving too slowly, and the longer we wait to commit to changing the way we live, the higher the price will become.

Given this backdrop, one of the key working assumptions in this assessment is that policies, programs, and best practices are needed to drive the requisite investments in the different innovation scenarios. As one recent analysis argued, if we are to achieve deep reductions in greenhouse gas emissions, promote a greater level of energy efficiency, and support innovations that invigorate a more robust economy as well as the many co-benefits (such as clean air and a better quality of life), it is "absolutely critical" to get the policy right [Busch, Harvey, 2016]. At the same time, however, if we are to achieve policy success, a dedicated workforce—in both the public and private sectors—is needed to plan, promote, and carry out programs to ensure the desired technology deployment.

Staff are also needed to ensure the training of people who will install and maintain the new technology systems as well as evaluate the actual success of the next policies and programs. To generate an estimate of what these incremental program costs might look like, the authors bor-

[13] As discussed in the subsequent section of this report, but the policy and program spending, as well as the energy efficiency investments themselves, can be paid through a variety of financial mechanisms that are offset by the energy bill savings.

row from a variety of studies including [Hoffman et al., 2014; Laitner, McDonnell, 2012; Wolfe, Brown, 2000], among many others. In this analysis the authors assume that program and policy expenditures might require about 20 percent of the scale of technology investment beginning today but declining to just 8 percent by 2050.

At the same time, we also build on previous work published by the International Partnership for Energy Efficiency Cooperation[14]. In addition, we tap into many other assessments to show the costs of inaction and why large-scale, meaningful, and informed investments are not only an economic imperative, but also make sense economically only if the scale of smart programs are in place to support the larger network of the investment opportunities.

6. The U.S. Energy Star Program as One Immediate Example of Effective Program Spending

Since its inception in 1992, and through the year 2014, the U.S. Environmental Protection Agency's Energy Star program has saved consumers and business a cumulative $362 billion in avoided energy costs. The net savings appear to be on the order of $31.5 billion in 2014 alone[15]. Those benefits have been the result of 16,000 partnerships and collaborations, relying primarily on a smart labeling program[16]. The program over the last 5 years—together with its many partnerships, marketing and online activities—appears to have driven an estimated annual investment of $20 billion per year in the purchase of much more energy-efficient products.

Energy Star emphasizes best practices in both the program design phase as well as the program implementation phase. For very basic program design the best practices include: conducting extensive market research; assessing the local home energy rating systems (HERS) infrastructure; assessing credentialed heating, ventilation and air conditioning (HVAC) contractors in the market; benchmarking construction practices; and identifying potential barriers to full program participation. In the program implementation phase the organizers should invest in marketing, set up strategic incentive structures, budget for staff training, conduct a cohesive communication strategy among stake-

[14] Energy Efficiency Networks: Towards Good Practices and Guidelines for Effective Policies to Stimulate Energy Efficiency. IPEEC Working Paper, 2017; G20 Energy Efficiency Investment Toolkit: G20 Energy Efficiency Finance Task Group (EEFTG) Case Studies. IPEEC, 2017. https://ipeec.org/upload/publication_related_language/pdf/636.pdf.

[15] Office of Atmospheric Programs Climate Protection Partnerships 2014 Annual Report. Washington, DC, U.S. Environmental Protection Agency, Climate Protection Partnerships Division (CPPD), 2016.

[16] Farrell M. Proposed Federal Budget Eliminates Energy Star: Popular Appliance-Labeling Program Saves Consumers $500 a Year. Consumer Reports, May 23, 2017. https://www.consumerreports.org/appliances/proposed-federal-budget-eliminates-energy-star/.

holders, and ensure sufficient investment in strong measurement and evaluation. Needless to say, all of this takes adequate funding to ensure success.

The best practices suggested by the Energy Star program align and support the thesis outlined in this paper. They show that the vast experience and success of the Energy Star program can provide very real benefits both to consumers directly, and to many collaborations and strong partnership programs that seek to improve as new insights and data emerge, and as evolving markets and new technologies continue to unfold.

7. Other Equally Effective Policies and Programs

Any number of studies and scenarios point to large opportunities and net benefits associated with a variety of energy efficiency improvements. However, most omit those key policy and program expenditures as part of their analytics or scenario evaluations. As in one example, the European Climate Foundation[17] provides a solid Roadmap 2050 showing that Europe could achieve an economy-wide reduction of GHG emissions of at least 80 percent compared with 1990 levels. But omitted in the analysis are the costs of policies and programs necessary to safeguard that positive outcome. Similarly, the well-known McKinsey study [Granade et al., 2009] found that, if executed at scale, a holistic energy efficiency investment in the U.S. economy would yield gross savings worth more than $1.2 trillion. This was anticipated to achieve a reduction of roughly 23 percent in projected energy demand, "well above the $520 billion needed through 2020 for upfront investment in efficiency measures", but again not including program costs. The assumptions appear to be that the program costs are relatively small, and that they will likely pay for themselves with lower energy costs, especially when externalities and the benefits from a more robust economy are included. But that "assumption" does not help policymakers from OECD and non-OECD nations understand the scale of what must be implemented to catalyze a positive outcome—hence, the review provided here.

A journal article by [Mundaca, Richter, 2015] provided an assessment of the 2009 stimulus package to review the full range of benefits associated with Green Energy Economy areas of the American Recovery and Reinvestment Act. While the report concluded that, overall, many benefits in energy savings and emissions as well as non-energy benefits were clearly documented, there were missteps when it came to program effectiveness. This was the result of a few key issues, including a lack of impact and evaluation reporting, lack of common data points,

[17] Roadmap 2050: a Practical Guide to a Prosperous, Low-Carbon Europe. European Climate Foundation (ECF), 2010. http://www.roadmap2050.eu/project/roadmap-2050.

as well as an incomplete measurement of social impacts, together with limited program level data.

It was also found that there were missed opportunities because of the lack of employee training in the use of newly funded technology; and there was a lack of communication and cooperation between organizations that would have made the programs much more cost-effective in the long term [Mundaca, Richter, 2015]. This supports the argument that stronger evaluation and measurement are needed in all programs, and brings to light the importance of organizations working together more closely so that their funding and available resources are more effectively deployed and put to work.

With the success of the Energy Star program, and with the review of the many difficulties arising from the investment of the 2009 stimulus package, there are many areas of improvement now recognized as needed in program organization. If adequately implemented, proper program organization could better support large and fast-moving investment that decreases risks and maximize both near-term and long-term successes. Yet again, this will require adequate and ongoing financial support as well as an active collaboration among many different parties. We next explore the range of policy and program costs.

8. Estimating Administrative and Overhead Program Costs

There are many benefits that spring from associated programmatic activities of governments. For example, the U.S. General Accounting Office[18] cites measurable financial benefits of $63.4 billion from its investigative work—a return of about $112 on every dollar of GAO spending. At a more local level, Colorado Governor John Hickenlooper[19] has noted that Colorado is home to nearly 30 federal labs and research institutions which attract some of the most innovative research conducted globally, contributing an estimated $2.6 billion to Colorado's economy annually and returning $5 for every $1 invested. To date, third-party evaluations for the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy[20] have found that a taxpayer investment of $12 billion has yielded a net economic benefit of more than $230 billion over time. The annual return on such investments is placed at more than 20 percent.

[18] Measurable Financial Benefits from GAO. Government Accounting Office (GAO). Washington, DC, 2017. http://www.gao.gov/about/gglance.html.

[19] Governor of the State of Colorado Executive Order D 2017-015. July 11, 2017. Denver, CO, Office of the Governor. https://www.colorado.gov/governor/sites/default/files/executive_orders/climate_eo.pdf.

[20] Preliminary Aggregate Net Benefits Calculation Combining Cost-Benefit Impact Results from Formal Evaluation Studies Conducted for EERE. Washington, DC, U.S. Department of Energy, 2017. https://www.energy.gov/eere/about-office-energy-efficiency-and-renewable-energy.

While the array of examples listed above reflect various kinds of non-specific government operations, to better understand the typical overhead costs associated with establishing and operating energy efficiency programs, we begin with a study that evaluated the prospects for an Energy Efficiency Resource Standard, which could become a highly useful energy productivity tool for the United States as whole. [Laitner et al., 2009] reviewed a modest 10 percent energy savings for natural gas and 15 percent for electric utilities by 2020 (within implied benefits extending out to 2032). Their analysis suggested a benefit-cost ratio of greater than 3.0 with a net gain of 247,000 jobs by 2020. Program costs were estimated to be 36 percent of the cumulative investment. As might be expected, the program costs included both administrative expenses and other overhead costs, but they also included incentives that might be given to utility customers as rebates to encourage their adoption of more energy-efficient technologies and best practices.

We can compare the estimated 36 percent scale of program costs with a review conducted by the Electric Power Research Institute[21]. The intent was to assess the energy efficiency potential for electric utilities in the United States through the year 2035. In that particular study, the analysis indicated that even with a number of efficiency initiatives already underway (beyond business-as-usual), a further reduction of 11 percent might be anticipated in 2035. Capturing the achievable potential assessed in that study over the forecast period would require a cumulative $401 billion in additional capital costs. The program administration costs were assumed to be 20 percent of the incremental costs of the technologies, or about $80 billion for utility-administered programs.

[Berry, 1989; 1991] reviewed the expenses incurred by utilities to administer demand-side management programs in the 1980s. Her work appears to provide the only published overview of administrative costs relevant to energy efficiency programs at that time. She estimated that those costs approached 20 percent of the incremental technological costs per unit of primary energy saved. This was perhaps not so surprising since both Berry as well as Wolfe and Brown were all working with the Oak Ridge National Laboratory at the time, and they frequently collaborated and shared relevant information in a timely way.

While the specific overhead costs of many energy efficiency programs cannot yet be determined, we can infer a set of administrative expenditures that might range between 10 and 30 percent of total incentive payments provided to program participants. Thus, the average

[21] U.S. Energy Efficiency Potential Through 2035. Technical Report 1025477. Electric Power Research Institute (EPRI). Palo Alto, CA, 2014. https://www.epri.com/#/pages/product/1025477/.

share of 20 percent of total incentive payments is specified as overhead costs in this study [Suerkemper et al., 2012]. To extend the analysis of what these incremental program costs might look like, the authors (of this current manuscript) borrow from a variety of studies including the already cited [Wolfe, Brown, 2000], and the previously referenced [Hoffman et al., 2014; Laitner, McDonnell, 2012; Laitner et al., 2012]. Following those insights, and as already discussed, the authors assume that program and policy expenditures for this analysis might require about 20 percent of the scale of technology investment beginning today, but declining to just 8 percent by 2050.

9. Evaluation, Monitoring and Verification (EM&V) Budget

Another key budget item to look at is the cost of Evaluation, Monitoring and Verification (EM&V) evaluations. This goes back to the need for cost-effective evaluations of program outcomes to both validate expected outcomes and also to ensure an ongoing review of program design and thus an even more positive result in the future. Sometimes EM&V may be included in the larger cost estimates, while other times it may be treated as a discrete expenditure. Yet, a robust EM&V is an essential component of any successful energy efficiency program. It should be typically kept in between 3 to 5 percent of program budget [Schwimmer, Fournier, 2014]. For a number of programs that have been identified, the separate monitoring and evaluation costs appear to average less than 3 percent of total utility costs—that is, before including customer costs or contributions to the efficiency improvements [Eto et al., 1996].

In most cases, and compared to an aggregate of total administrative costs, EM&V budgets were reported to vary between 1 and 5 percent of the program budget with most recommendations between 3 and 5 percent of the total budget. In a review of 15 states where EM&V budgets were reported for energy efficiency programs the average had 3 percent of the total budget set aside of EM&V activities[22].

EM&V provides valuable data that can help close the gap in needed information to quickly and effectively deploy energy efficiency programs at a high level, and because of this EM&V should always be included in program budgets and be conducted throughout as well as after the program has ended. The data from these evaluations can help future programs build off of past successes and learn from past failures, both being imperative to a solid understanding when deploying programs quickly and effectively.

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[22] Energy Efficiency Program Impact Evaluation Guide: Evaluation, Measurement, and Verification Working Group. Washington D.C.: State and Local Energy Efficiency Action Network (SLEEAN), 2012.

Conclusion and Opportunity—If the Choice Is Made

The evidence is compelling—immediate solutions are warranted to address climate change on the one hand, but also to ensure a robust and sustainable economy through the greater use of energy and resource productivity[23] on the other. Addressing these needs at scale will also require large-scale funding and investments. Equally compelling, however, is the need for a policy-driven response that is supported by adequately funded program and administrative support. In short, funding for technology solutions alone may not achieve an optimal outcome—either at sufficient scale or with the right combination of programs, incentives and efforts. Therefore, there is the need for initiatives that also provide funding support for smart policies and programs that are more likely to guarantee the kind of returns that will enable smart climate and will allow social and economic solutions to emerge. The need is there, the opportunity is there, and the returns can be generated at scale—but only if the appropriate choices are made.

References

1. Ayres R. U., Warr B. *The Economic Growth Engine: How Energy and Work Drive Material Prosperity*. Northampton, MA, Edward Elgar Publishing Inc., 2009.
2. Berry L. G. *The Administrative Costs of Energy Conservation Programs*. ORNL/CON-294, Oak Ridge National Laboratory, 1989.
3. Berry L. G. The Administrative Costs of Energy Conservation Programs. *Energy Systems and Policy*, 1991, vol. 15, pp. 1-21.
4. Blok K., Hofheinz P., Kerkhoven J. *The 2015 Energy Productivity and Economic Prosperity Index: How Efficiency Will Drive Growth, Create Jobs and Spread Wellbeing Throughout Society.* Utrecht, Netherlands, 2015. https://www.ctc-n.org/resources/2015-energy-productivity-and-economic-prosperity-index-how-efficiency-will-drive-growth-0.
5. Busch C., Harvey H. *Climate Policy for the Real World: California's Proven Approach to Building an Effective, Efficient, and Fair Package of Climate Policies*. Energy Innovation LLC, 2016. http://energyinnovation.org/wp-content/uploads/2016/11/Climate-Policy-for-the-Real-World-June-2016.pdf.
6. Coady D., Parry I. W. H., Sears L., Shang B. How Large Are Global Energy Subsidies? *International Monetary Fund Working Paper*, no. 15/105, 2015.
7. *Drawdown: The Most Comprehensive Plan Ever Proposed to Reverse Global Warming*. P. Hawken. (ed.). L., Penguin Books, 2017.
8. Ekins P., Hughes N. *Resource Efficiency: Potential and Economic Implications: A Report of the International Resource Panel*. United Nations Environment Program, 2017. https://www.resourcepanel.org/sites/default/files/documents/document/media/resource_efficiency_report_march_2017_web_res.pdf.
9. Eto J., Vine E., Shown L., Sonnenblick R., Payne C. The Total Cost and Measured Performance of Utility-Sponsored Energy Efficiency Programs. *The Energy Journal*, 1996, vol. 17, no. 1, pp. 31-51.
10. Granade H. Ch., Creyts J., Derkach A., Farese Ph., Nyquist S., Ostrowski K. *Unlocking Energy Efficiency in the U.S. Economy.* McKinsey & Company. U.S., Vermont, Milton, Villanti & Sons, Printers Inc., 2009. https://www.mckinsey.com/~/media/mckinsey/dotcom/

[23] Investing in Climate, Investing in Growth.

client_service/epng/pdfs/unlocking%20energy%20efficiency/us_energy_efficiency_exc_summary.ashx.

11. Hoffman I. M., Rybka G., Leventis G., Goldman C.A., Schwartz L., Billingsley M., Schiller S. *The Total Cost of Saving Electricity Through Utility Customer-Funded Energy Efficiency Programs-Estimates at the National, State, Sector and Program Level*. https://emp.lbl.gov/publications/total-cost-saving-electricity-through.
12. Huntington H., Weyant J., Sweeney J. Modeling for Insights, Not Numbers: The Experiences of the Energy Modeling Forum. *Omega: The International Journal of Management Science*, 1982, vol. 10, no. 5, pp. 449-462.
13. Jacobson M. Z., Delucchi M. A., Bauer Z. A. F. 100% Clean and Renewable Wind, Water, and Sunlight All-Sector Energy Roadmaps for 139 Countries of the World. *Joule*, 2017, vol. 1, no. 1, pp. 108-121.
14. Keyser D., Mayernik J. M., McMillan C., Agan J., Kempkey N., Zweig J. *Accelerate Energy Productivity 2030: A Strategic Roadmap for American Energy Innovation, Economic Growth, and Competitiveness*. Washington, DC, U.S. Department of Energy, 2015.
15. Kümmel R. *The Second Law of Economics: Energy, Entropy, and the Origins of Wealth*. N. Y., NY, Springer, 2011.
16. Kümmel R. Why Energy's Economic Weight Is Much Larger Than Its Cost Share. *Environmental Innovation and Societal Transitions*. 2013, vol. 9, pp. 33-37.
17. Laitner J. A. Linking Energy Efficiency to Economic Productivity: Recommendations for Improving the Robustness of the U.S. Economy. *Wiley Interdisciplinary Reviews: Energy and Environment,* 2015, vol. 4, no. 3, pp. 235-252.
18. Laitner J. A. *Working Memorandum on Energy as Work*. Tucson, AZ, Economic and Human Dimensions Research Associates, 2019. https://theresourceimperative.com/wp-content/uploads/2019/10/Laitner-Working-Memorandum-on-Energy-as-Work-October-15-2019.pdf.
19. Laitner J. A., Furrey L., Nadel S. *The National Energy Efficiency Resource Standard as an Energy Productivity Tool*. Washington, DC, American Council for an Energy Efficient Economy, 2009.
20. Laitner J. A., Lebot B., McDonnell M., Weiland M. *Smart Policies and Programs as Critical Drivers for Greater Energy Efficiency Investments*. A Working paper for the International Partnership of Energy Efficiency Cooperation (IPEEC), 2018. https://theresourceimperative.com/wp-content/uploads/2018/02/IPEEC-Smart-Policies-and-Programs-as-Critical-Drivers-of-Greater-Energy-Efficiency-Investments-Feb-2018.pdf
21. Laitner J. A., McDonnell M. T. *Securing Nebraska's Energy and Economic Future: Creating Jobs, New Economic Opportunities and Health Benefits Through Productive Investments in Wind Energy and Energy Efficiency*. Madison, WI, Sierra Club, 2012.
22. Laitner J. A., Nadel S., Sachs H., Elliott R. N., Khan S. *The Long-Term Energy Efficiency Potential: What the Evidence Suggests*. ACEEE Research Report E104, 2012.
23. Mundaca L., Richter J. L. Assessing 'Green Energy Economy' Stimulus Packages: Evidence from the U.S. Programs Targeting Renewable Energy. *Renewable and Sustainable Energy Reviews*, 2015, vol. 42, pp. 1174-1186.
24. Nadel S. Pathway to Cutting Energy Use and Carbon Emissions in Half. *ACEEE Working Paper*, 2016.
25. Schwimmer A., Fournier A. *Energy Efficiency Quick Start Programs: A Guide to Best Practices.* Atlanta, GA, Southeast Energy Efficiency Alliance, 2014. https://www.seealliance.org/wp-content/uploads/Quick-Start-Best-Practices-041414-FINAL.pdf.
26. Stern N. *Why Are We Waiting? The Logic, Urgency, and Promise of Tackling Climate Change.* Cambridge, MIT Press, 2015.
27. Suerkemper F., Thomas S., Osso D., Baudry P. Cost-Effectiveness of Energy Efficiency Programmes-Evaluating the Impacts of a Regional Programme in France. *Energy Efficiency*, 2012, vol. 5, no. 1, pp. 121-135.

28. Teske S., Mills J., Loeffelbein T., Kaiser M. *Energy Revolution. A Sustainable World Energy Outlook 2015*. https://www.karlsruhe.greenpeace.de/sites/www.karlsruhe.greenpeace.de/files/gp-report_energy-revolution-2015_summary.pdf.
29. Von Baeyer H. C. *The Fermi Solution: Essays on Science.* N. Y., Random House, 1993.
30. Voudouris V., Ayres R., Serrenho A.C., Kiose D. The Economic Growth Enigma Revisited: The EU-15 Since the 1970s. *Energy Policy*, 2015, vol. 86, pp. 812-832.
31. Wolfe A., Brown M. Estimates of Administrative Costs for Energy Efficiency Policies and Programs. Appendix E-1 in: Interlaboratory Working Group, *Scenarios for a Clean Energy Future*, 2000.
32. Zuckerman J., Frejova J., Granoff I., Nelson D. *Investing at Least a Trillion Dollars a Year in Clean Energy. Contributing Paper for Seizing the Global Opportunity: Partnerships for Better Growth and a Better Climate.* New Climate Economy, L., Washington, DC, 2016. http://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2016/05/NCE_CleanEnergy_financing_final_web-Copy.pdf.